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Research Report

Early Blindness May Be Associated with Changes in Performance on Verbal Fluency Tasks

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Studies of how children who are blind acquire and use language have focused less on cognitive compensations and more on delays in development. Vision is important in the establishment of early communicative patterns, and sighted children regularly use contextual visual information, such as a speaker's gestures and eye gaze, to make sense of speech that is directed at them (Mills, 1988). Some researchers have argued that, in the absence of vision, children may be expected to have more difficulty understanding concepts and the relationships between them and in acquiring generalizations about language and the way it works (Andersen, Dunlea, & Kekelis, 1993). In contrast, it has been argued that linguistic experience may be more important for children who are blind than for sighted children and that children who are blind may pay more attention to language (Chomsky, 1990; Perez-Pereira & Castro, 1997).

It seems that children who are blind may show an uneven pattern of language development. Andersen et al. (1993) proposed that in children who are blind, language follows an alternative path of development, with a combination of both relative delays and advantages compared to the development of language by sighted children. Mulford (1988) reported that children who were blind had acquired fewer terms for animals and more terms for household items than did sighted children of the same age, possibly because of their different linguistic experiences. Overall, however, the vocabularies of the blind and sighted children are remarkably similar, given the apparent key interplay among vision, language, and cognition (Mills, 1988).

This report examines the question of whether apparent compensatory changes in verbal fluency are concomitant with early blindness. In the semantic version of the Controlled Oral Word Association Task (COWAT), participants orally generate as many words as possible that fit into a particular semantic category, such as animals (Benton, 1994). For the phonemic task, they name as many words as possible that begin with a chosen sound, usually /f/, /a/, and /s/.

Research has suggested that despite the apparent similarity between the semantic and phonemic tasks, the tasks may be dissociable in certain groups (see, for example, Troyer, Moscovitch, Winocur, Alexander, & Stuss, 1997). Several lines of evidence suggest that children who are blind may perform differently on the semantic and phonemic tasks because they may lack a full understanding of the meanings of words (Pring, 1988) and hence may find the semantic task relatively harder. Data also suggest that there may be an advantage for children who are blind on the phonemic fluency task. For instance, Lucas (1984) showed that children who were blind had an advantage identifying mispronounced words in a story. Röder, Rösler, and Neville (2000) also reported that adults who were blind detected incongruous endings in sentences faster than did sighted adults in a control group. They speculated that this advantage may have arisen from input from an initial phoneme.

According to Troyer, Moscovitch, and Winocur (1997), two dissociable components underlie verbal fluency performance. The first component is clustering, which involves accessing a store of semantically or phonemically related words. In the animals subtest, examples would include producing a sequence of words from the category of "typical pets," such as *cat*, *dog*, and *goldfish*. In the phonemic task, words, such as *tree*, *true*, and *trim*, which begin with the same two letters, would represent a phonemic cluster. The second component is switching, which is the search for new semantic or phonemic clusters. Efficient switching increases the number of correct words because it allows new words to be produced once all the exemplars in a given cluster have been exhausted.

The goal of the study presented here was to discover if there are differences between children who are blind and children who are sighted in verbal fluency, particularly whether there are differences in clustering and switching in fluency tasks. The data reported here were collected concurrently with a larger data set reported in Wakefield, Homewood, and Taylor (2004).

Hypotheses

Given the literature described earlier, we hypothesized that the verbal fluency scores of children who are blind would be significantly higher than those of sighted children in a control group, particularly in the phonemic fluency task. We further hypothesized that this advantage may be reflected in a greater use of clustering or switching strategies to increase the number of words produced by the children who are blind relative to those produced by the sighted children.

Methods

PARTICIPANTS

The participants were 16 children who were attending a residential music camp for children with visual impairments in Australia. The children ranged in age from 11 to 18 (mean: 15.11 years). Of the 16, 13 were blind at birth and 3 became blind before their first birthday. Six children had no light perception, 8 had light perception only, and 2 were legally blind (visual acuity worse than 6/60 [20/200]). Their diagnoses included retinopathy of prematurity (n = 7), Leber's amaurosis (n = 5), and retinoblastoma (n = 1). The parents of the remaining 3 children described the cause of their blindness as an unknown birth or genetic defect. All the children began to learn braille before they were 6 years old. Reports by the parents and teachers suggested that all the children had normal cognitive development and hearing. Two children in this group reported taking daily medication for epilepsy.

Eighteen sighted children were recruited from the community and matched for age (range: 11-18 years, mean: 14.67 years), gender, and musical experience (measured by years of musical experience and hours per week playing their chosen instrument). Musical experience was not related to performance on the verbal fluency tasks or to clustering or switching. All the children in both groups spoke English as their primary language. The parents of 56% of the blind children and 50% of the sighted children were born in Australia.

Procedure

Informed consent was obtained from each child and primary caregiver, who provided a short medical and educational history. The children completed a battery of paired associate learning tasks and olfactory naming and sensitivity tasks prior to the verbal fluency tasks. The results and procedures that were used to collect these data are described in full in Wakefield et al. (2004).

Four verbal fluency tasks were given. The two semantic fluency tasks asked the children to recite, in a 60-second period, "all the things you might find around the house" and "all the things you might find in the supermarket" and were preceded by a practice task of "all the animals you can think of." The two phonemic fluency tasks asked for the words "that start with the sound /s/" and then /p/. A practice phonemic trial was completed with the sound /t/.

Three scores were allocated to each child for each task: the total number of words produced (minus repetitions and errors), the average size of the clusters, and the number of switches. Scoring for the size of clusters and number of switches that were generated in the tasks followed the method outlined by Troyer, Moscovitch, and Winocur (1997). The size of a cluster is the number of words that are produced per "burst" of semantically or phonemically related responses minus the first word. Semantic clusters were defined as groups of successively generated words that belonged to the same semantic subcategory (such as furniture, kitchen appliances, and electrical goods for the house task or cleaning products, fruit, and dairy products for the supermarket task). For phonemic fluency, clusters were defined as groups of words that began with the same first two letters (such as *stay*, *star*, and *stand*), had the same first and last letters (such as *put*, *pat*, and *pot*), rhymed (such as *pot* and *plot*), or were homonyms described by the child (such as *sum* and *some*).

The number of switches was calculated by counting the number of changes to new semantic or phonemic categories. Typically, switches are preceded by a slight pause before another cluster of words is produced. All the responses were manually scored during testing and were audiotaped. The taped material was used to confirm all the scores by the same researcher who conducted the tests.

Results

The mean scores for all the children on the verbal fluency task are presented in Figure 1. Independent two-tailed *t*-tests revealed no significant difference in the average semantic fluency scores between the blind and sighted children ($t_{32} = -1.934$, $p = .062$). In contrast, there was a significant difference, favoring the children who were blind, on the phonemic fluency task ($t_{32} = 3.059$, $p = .005$). The fluency task-visual status interaction was significant ($F_{(1,32)} = 19.89$, $p < .0005$). No other interactions were tested in these analyses.

Table 1 shows the mean cluster size and the number of switches for both groups. The children who were blind made significantly more switches in the phonemic task than did the sighted children ($t_{32} = 3.485$, $p = .001$).

Discussion

In contrast to many investigations that have focused on disability, the aim of this study was to determine if children who are blind show specific advantages on word-fluency tasks. The results indicate that the children who

became blind before their first birthday outperformed the sighted children on the phonemic, but not on the semantic, fluency tasks. This apparent cognitive compensation for blindness may have arisen from the significantly larger number of switches made by the children who were blind on the phonemic task.

Why was there an advantage for the children who were blind on the phonemic task? First, it is possible that the strategy used by the sighted children to boost their performance on the semantic task, most likely visualization of a house or a supermarket, does not transfer well to the phonemic task. Nonvisual imagery, however, can be used in both the semantic and the phonemic tasks and may be more useful in the phonemic task because words can be drawn from classes of abstract words or acoustically similar words. Hence, different amounts of experience with the use of nonvisual imagery by the sighted and blind children may have accounted for the advantage of the children who were blind on the phonemic task.

The second possible basis of superior performance is that the children who were blind made more switches than did the sighted children in the phonemic task. Ho et al. (2002) pointed out that switching has a differential effect on the performance of phonemic and semantic tasks because there are more possible categories in phonemic tasks. Recall that Röder et al. (2000) reported data that are consistent with the hypothesis that adults who are blind process auditory language faster than do sighted adults, possibly because of increased attention to the initial phoneme. It is possible that this enhanced ability to switch to new clusters has arisen from extra attention to the first phoneme. This possibility would explain why we found differences only on phonemic, not on semantic, switching.

The proposal that the children who were blind outperformed the children who were sighted because of enhanced attention to the first phoneme is supported by data that suggest that performance on verbal fluency tasks is sensitive to attentional load. Troyer, Moscovitch, and Winocur (1997) asked sighted participants to perform a semantic fluency task while tapping their fingers in a specified pattern. The participants produced fewer words and made fewer switches in the phonemic, but not the semantic fluency, task, implying that they were more affected by the distraction of the finger tapping in the phonemic task. Taken as a whole, these findings suggest that one cognitive compensation for blindness may be an enhanced ability to direct attention.

In this research, we could find no significant differences between the

children who were blind and the children who were sighted on the semantic fluency task. Perez-Pereira and Conti-Ramsden (1999) concluded that the most prudent interpretation of the limited data on language development in blind children is that there are large individual differences and that it is difficult to point to areas where consistent differences have been found. As others have noted, language development and profiles of children who are blind who have no concomitant handicaps constitute a natural experiment. To the extent that the semantic fluency measure derived from COWAT and cluster size reflects the structure and organization of the lexicon, the data reported here suggest that this aspect of cognitive development is remarkably similar in children with and without vision.

Despite the potential impact on theories of cognition and language development of investigations of children who develop without vision, little work has been done with this group. Methodologically sound research in this area is difficult to conduct because of the co-occurrence of blindness with other handicaps. The sample reported here was selected on the basis of parents' and teachers' reports to be those without additional neurological handicaps, and all were attending neighborhood schools. Hence, the results may not be applicable to all children who are blind.

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